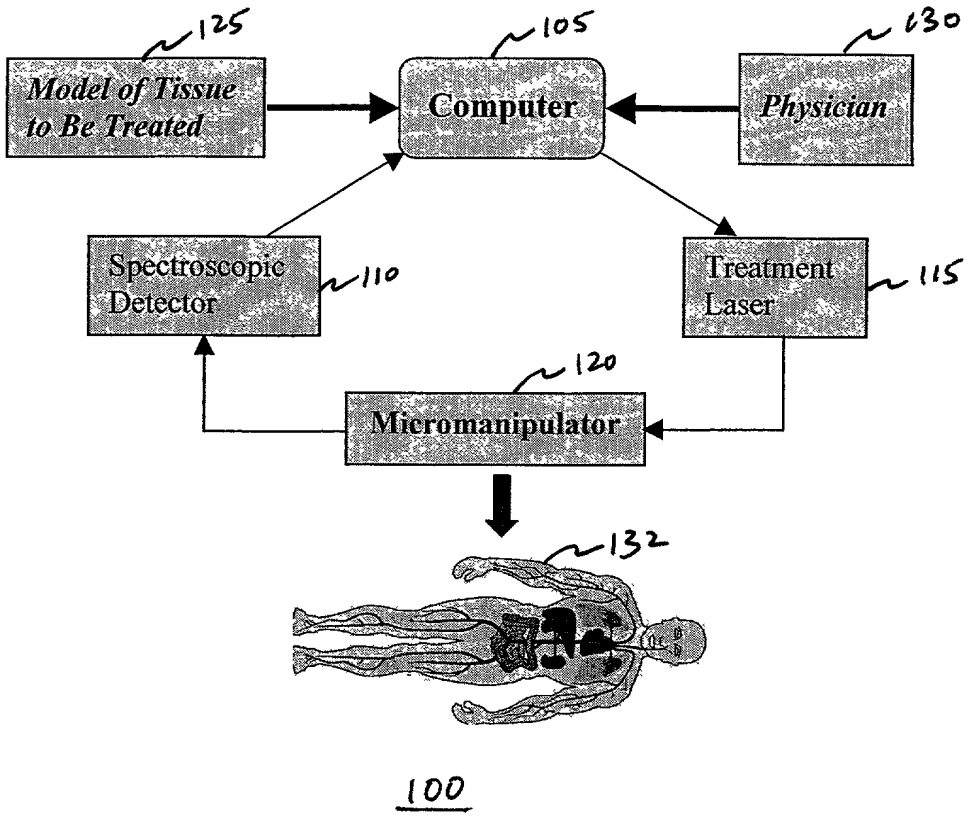

125
Model of Tissue to Be Treated
105
Computer
130
Physician
Spectroscopic Detector
110
Treatment Laser
115
120
Micromanipulator
132
100

FIG. 1A

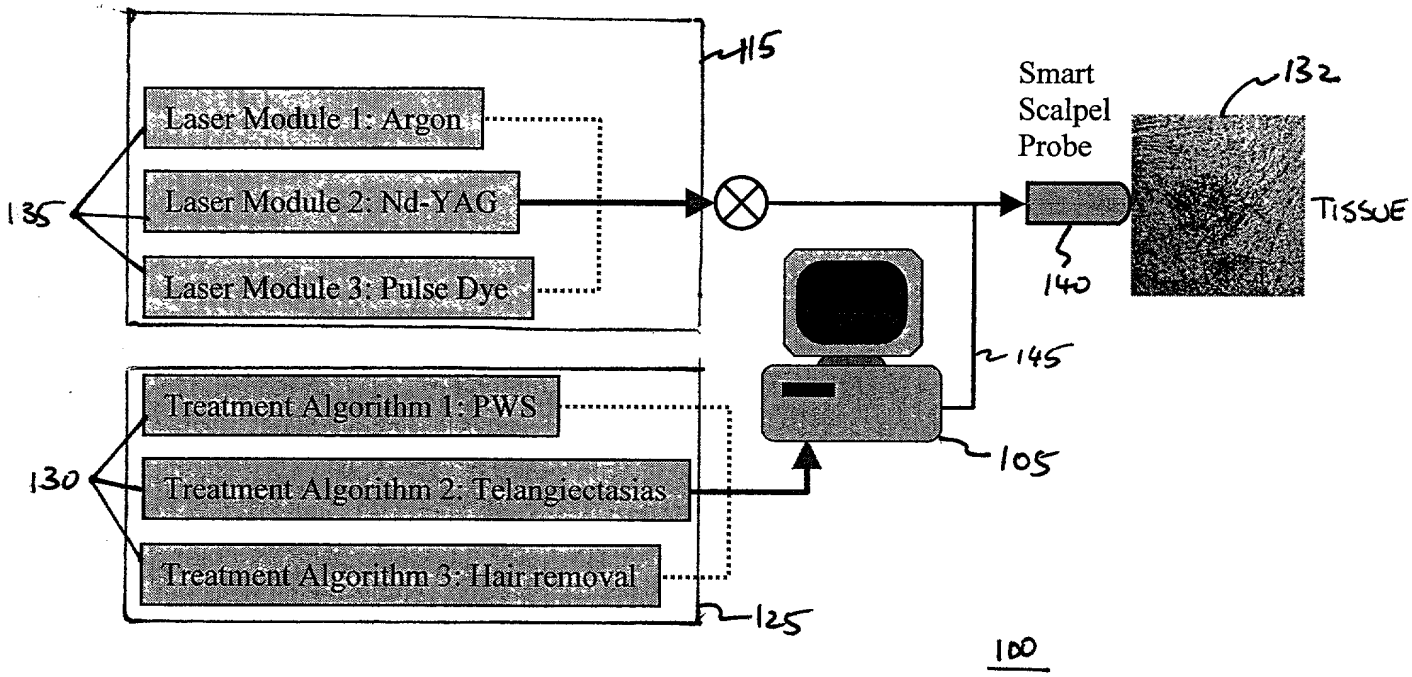
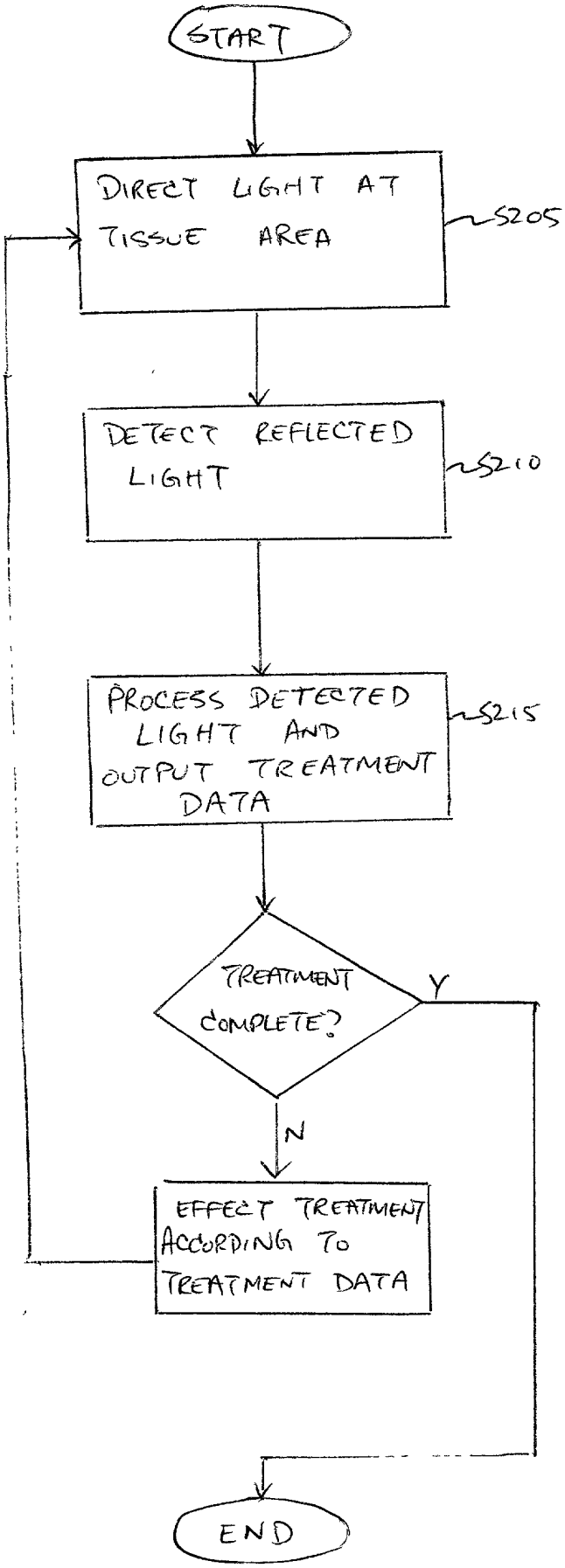

115
Laser Module 1: Argon
Laser Module 2: Nd-YAG
Laser Module 3: Pulse Dye
135
Smart Scalpel Probe
132
TISSUE
140
145
105
Treatment Algorithm 1: PWS
Treatment Algorithm 2: Telangiectasias
Treatment Algorithm 3: Hair removal
130
125
100

FIG. 1B


START
DIRECT LIGHT AT TISSUE AREA
S205
DETECT REFLECTED LIGHT
S210
PROCESS DETECTED LIGHT AND OUTPUT TREATMENT DATA
S215
TREATMENT COMPLETE?
Y
N
EFFECT TREATMENT ACCORDING TO TREATMENT DATA
END

200

FIG. 2

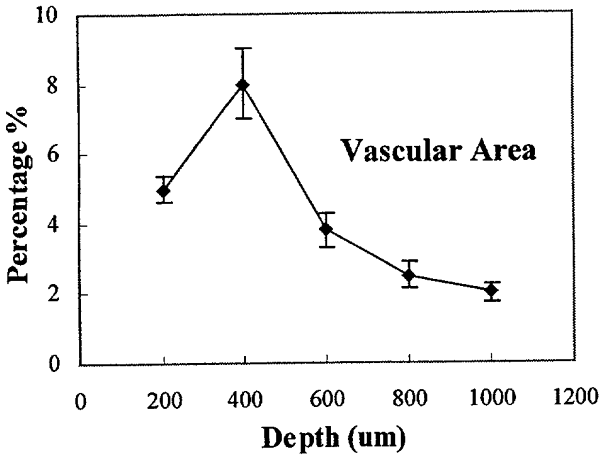


FIG. 3A

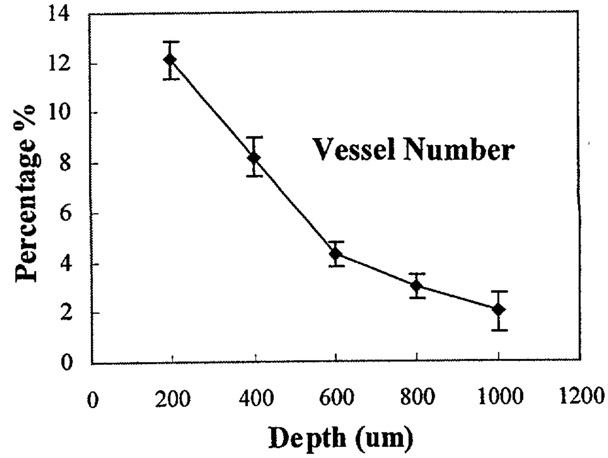


FIG. 3B

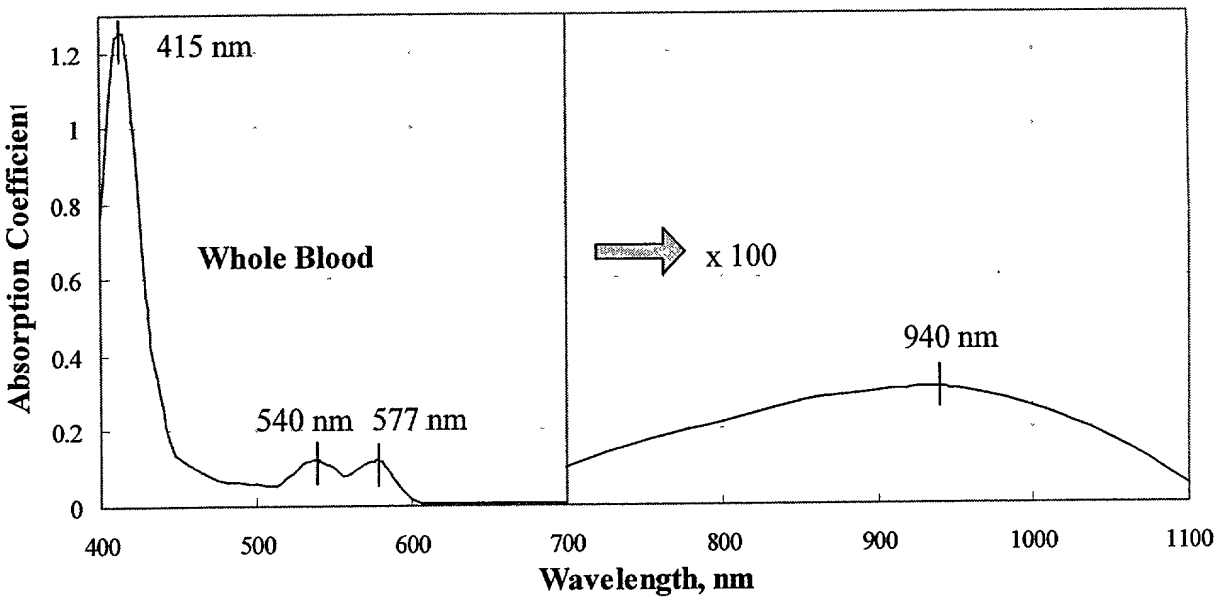

415 nm
Whole Blood
x 100
940 nm
540 nm
577 nm
Absorption Coefficient
Wavelength, nm
0
0.2
0.4
0.6
0.8
1
1.2
400
500
600
700
800
900
1000
1100

FIG. 4

Laser	Wavelength (nm)	Treat Fluence (J/cm^2)	Type
Argon	488, 514	1-10	CW
Classic KTP	532	10-40	CW
Cu or Cu-Br	512-578	1-10	CW
Krypton	570	1-10	CW
Pulse dye (yellow)	585	4-8	Pulsed
Derm-KTP	532	2-20	Pulsed
Pulsed dye (green)	510	3-5	Pulsed
Q-sw. Nd:YAG – green - infrared	532 1064	3-5 4-10	Pulsed
Q-sw. Ruby (red)	694	4-10	Pulsed
Q-sw. Alexandrite (infrared)	755	4-10	Pulsed

FIG. 5

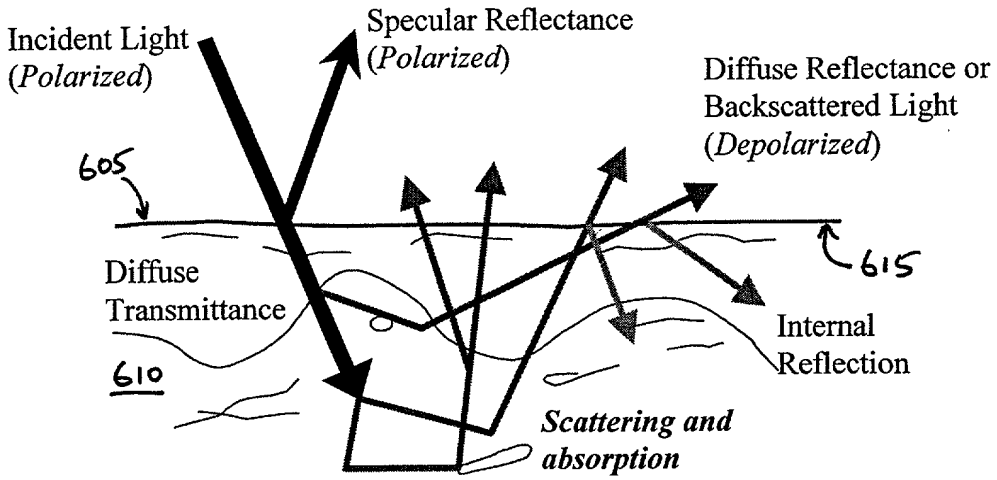


FIG. 6

Tissue	λ (nm)	μ_a (mm^{-1})	μ_s (mm^{-1})	*G*	μ_s' (mm^{-1})	μ_t (mm^{-1})
Human dermis	633	0.27	18.7	0.81	3.553	3.823

FIG. 7

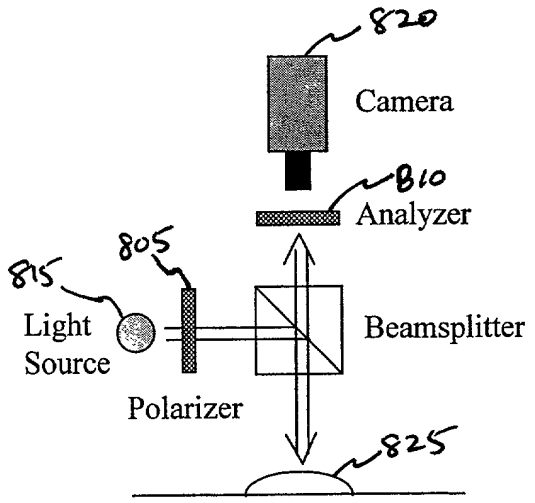


FIG. 8A

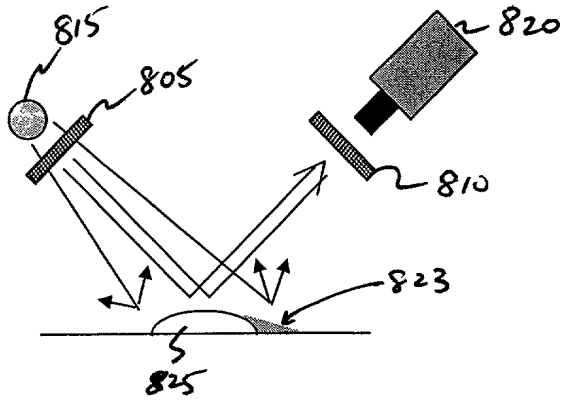


FIG. 8B

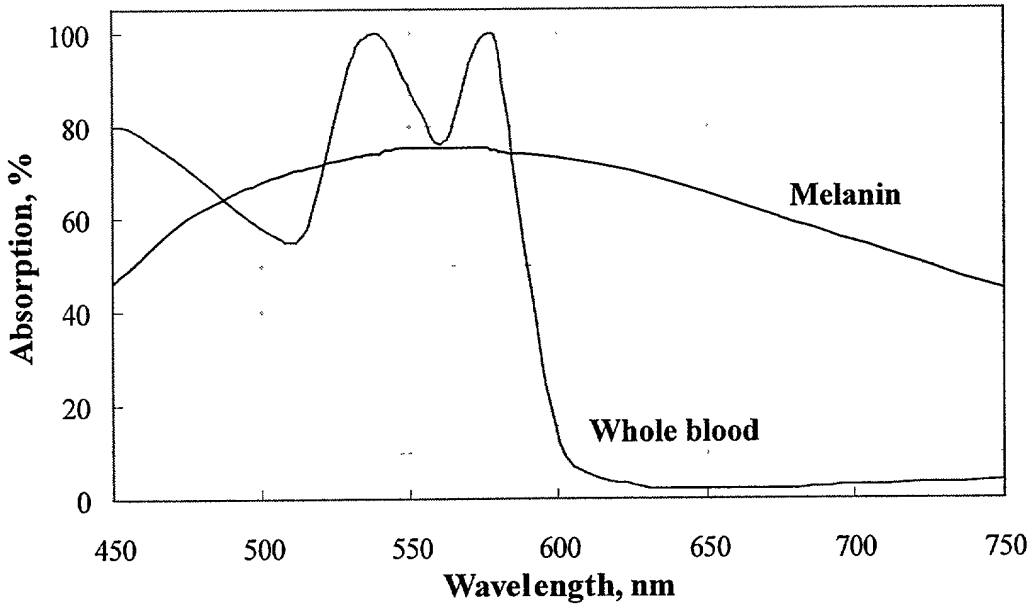


FIG. 9

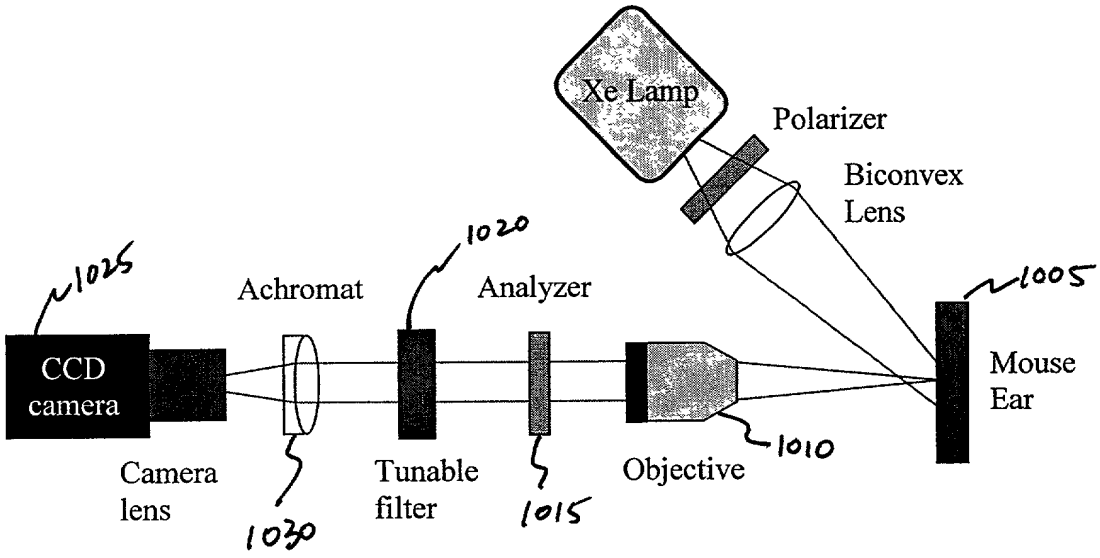

Xe Lamp
Polarizer
Biconvex
Lens
1005
Mouse
Ear
1020
Analyzer
1025
Achromat
CCD
camera
Camera
lens
1030
Tunable
filter
1015
Objective
1010
1000

FIG. 10

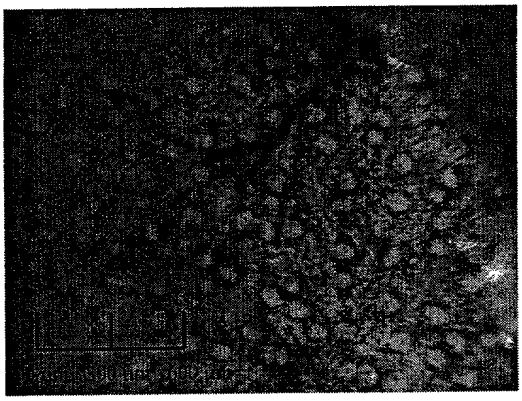


FIG. 11A

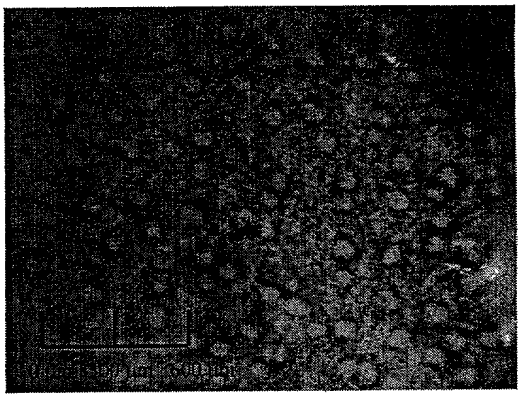


FIG. 11B

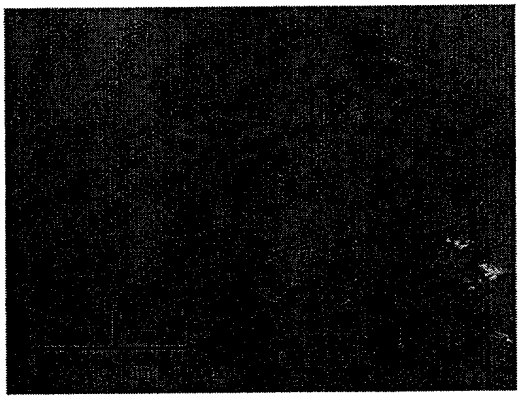


FIG. 11C

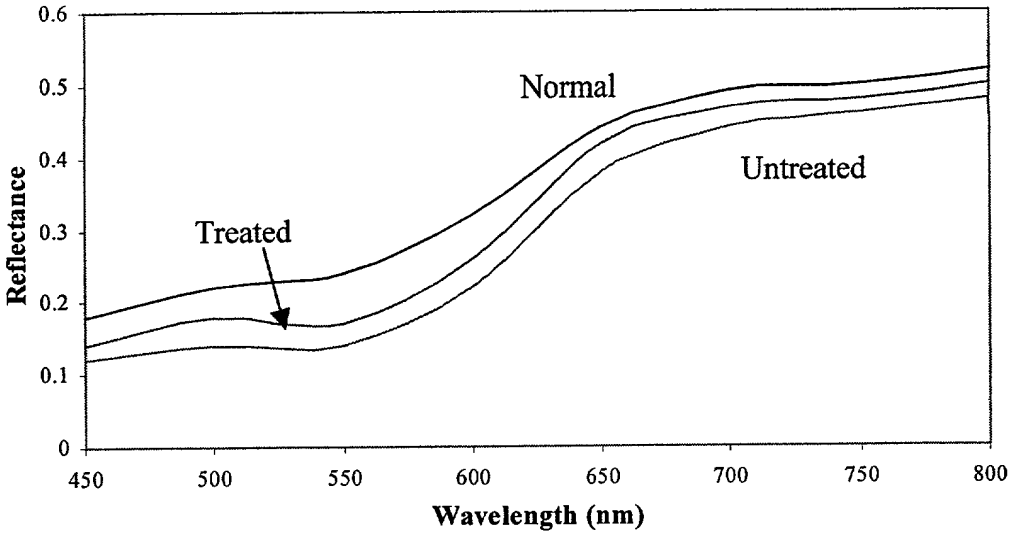
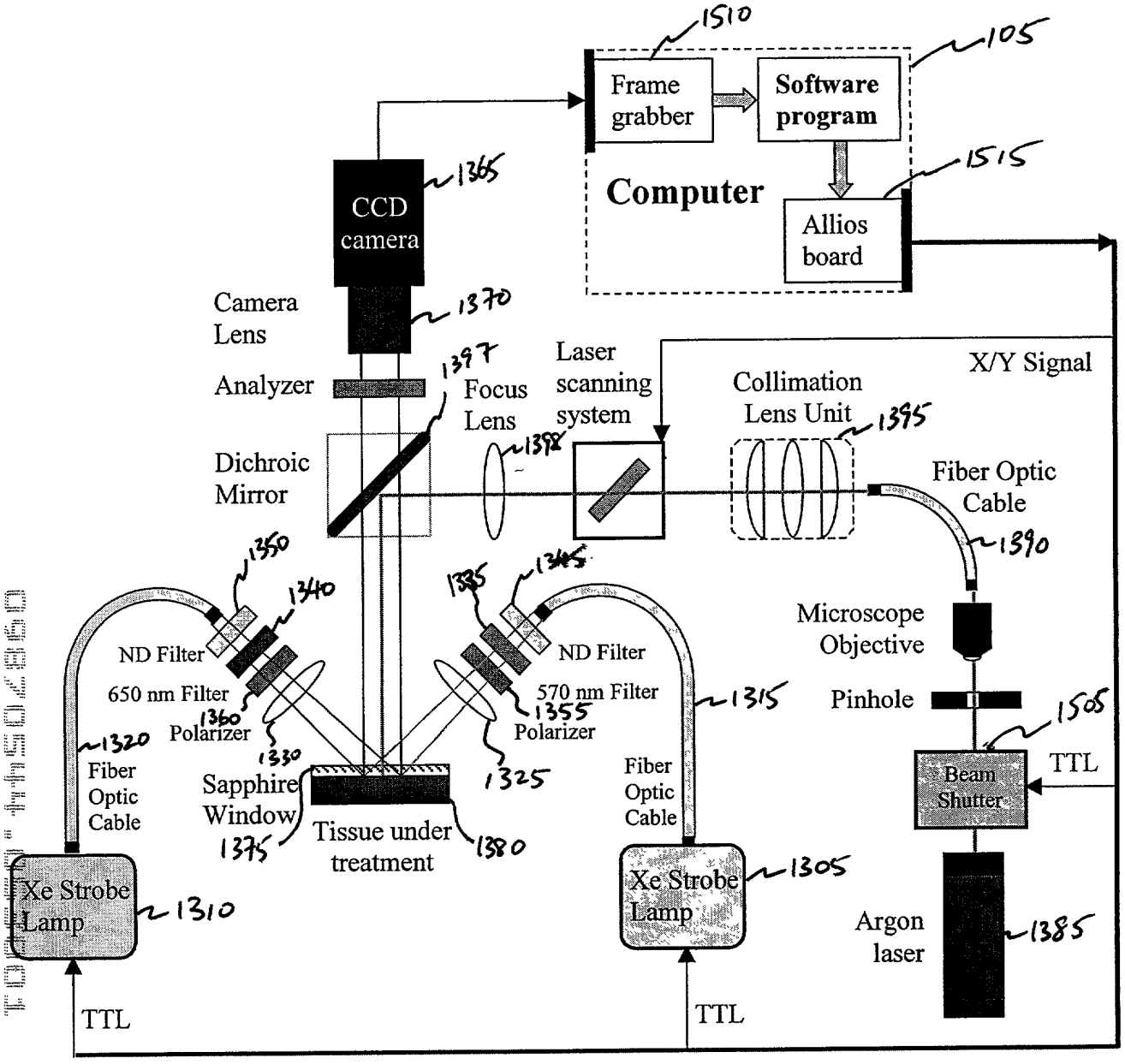

0.6
0.5
0.4
0.3
0.2
0.1
0
Reflectance
Normal
Untreated
Treated
450
500
550
600
650
700
750
800
Wavelength (nm)

FIG. 12


1510
105
Frame grabber
Software program
Computer
1515
Allios board
CCD camera
1365
Camera Lens
1370
Analyzer
1397
Focus Lens
Laser scanning system
X/Y Signal
Collimation Lens Unit
1395
Dichroic Mirror
1392
Fiber Optic Cable
1390
1350
1340
1345
1335
Microscope Objective
ND Filter
650 nm Filter
1360
Polarizer
ND Filter
570 nm Filter
1355
Polarizer
1315
Pinhole
1505
1320
Fiber Optic Cable
1330
Sapphire Window
1375
1325
Tissue under treatment
1380
Fiber Optic Cable
Beam Shutter
TTL
Xe Strobe Lamp
1310
Xe Strobe Lamp
1305
Argon laser
1385
TTL
TTL

1300

FIG. 13

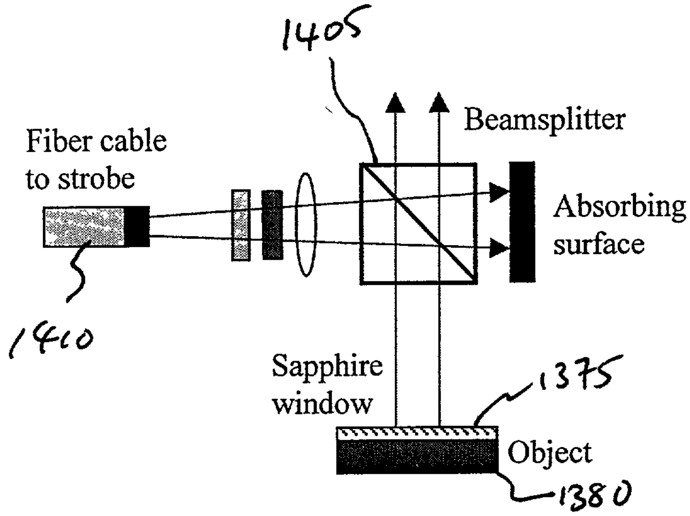


FIG. 14

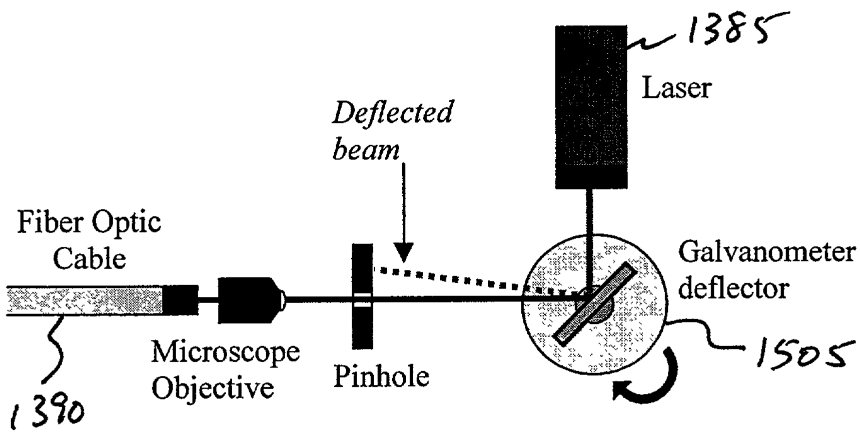


FIG. 15

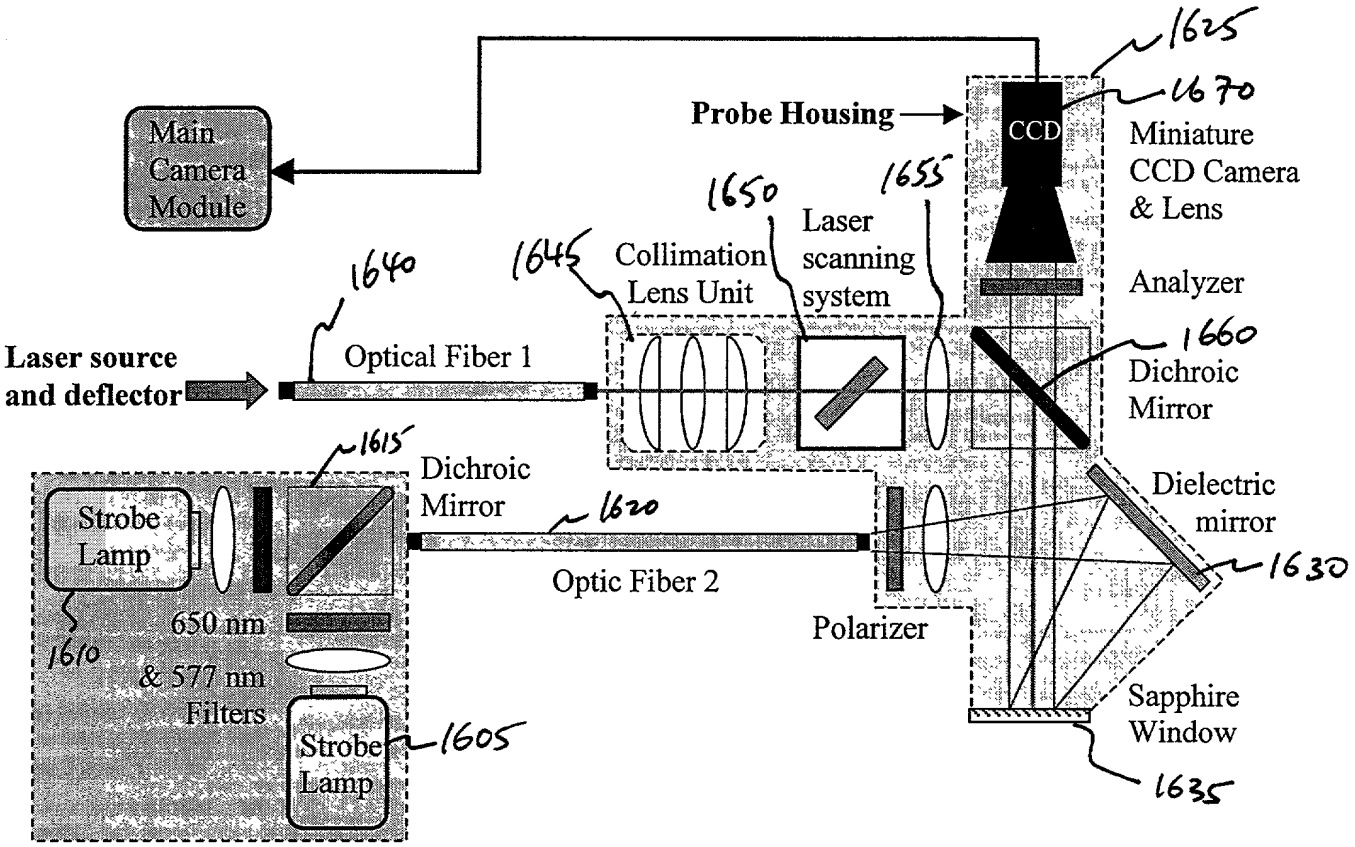

Main Camera Module
Probe Housing
CCD
Miniature CCD Camera & Lens
Analyzer
Laser source and deflector
Optical Fiber 1
Collimation Lens Unit
Laser scanning system
Dichroic Mirror
Strobe Lamp
650 nm & 577 nm Filters
Dichroic Mirror
Optic Fiber 2
Polarizer
Dielectric mirror
Sapphire Window
Strobe Lamp
1600

FIG. 16

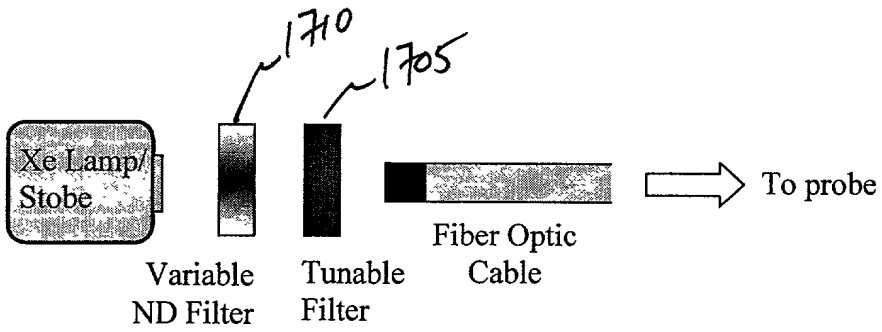

1710
1705
Xe Lamp/
Stobe
To probe
Fiber Optic
Cable
Variable
ND Filter
Tunable
Filter

FIG. 17

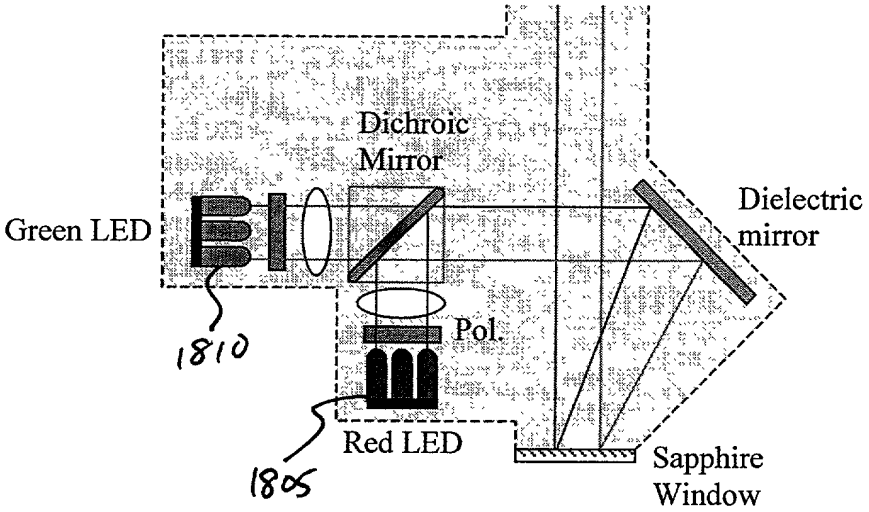

Dichroic
Mirror
Green LED
Dielectric
mirror
1810
Pol.
Red LED
1805
Sapphire
Window

FIG. 18

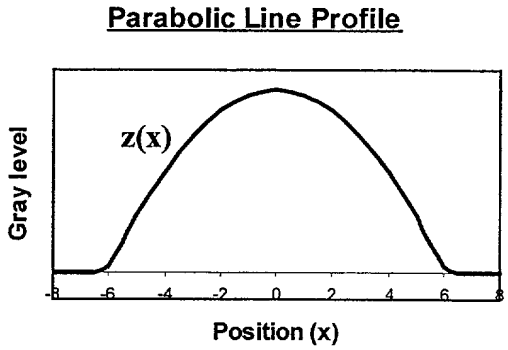


FIG. 19A

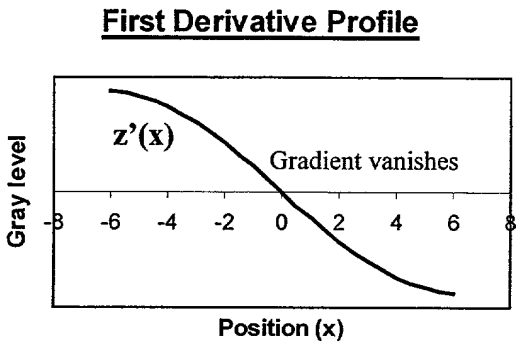


FIG. 19B

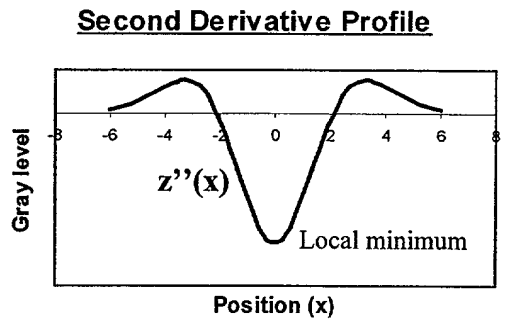
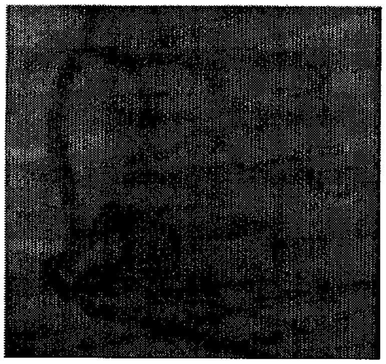


FIG. 19C



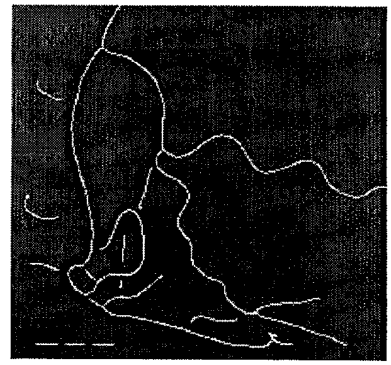


FIG. 20A

FIG. 20B

FIG. 20C

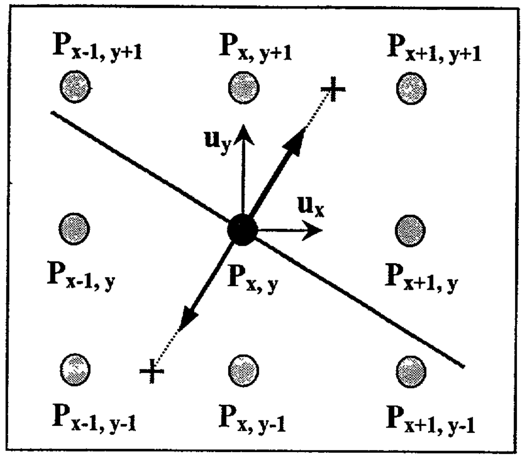


FIG. 21

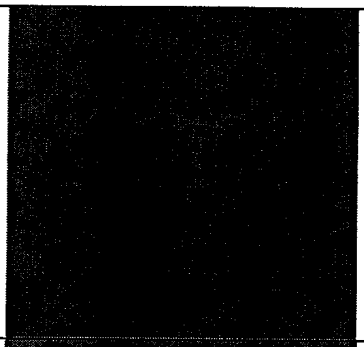
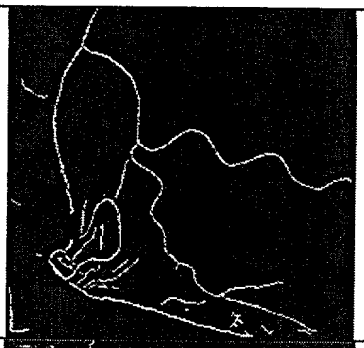
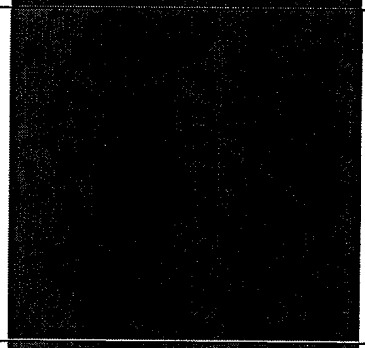
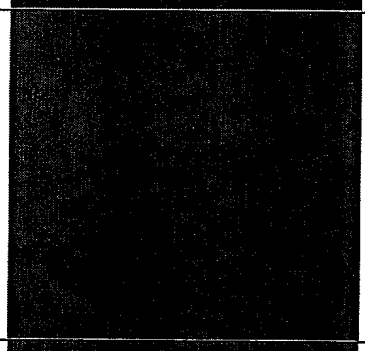
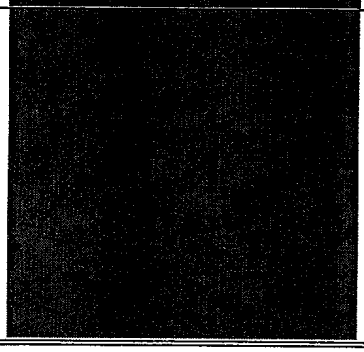
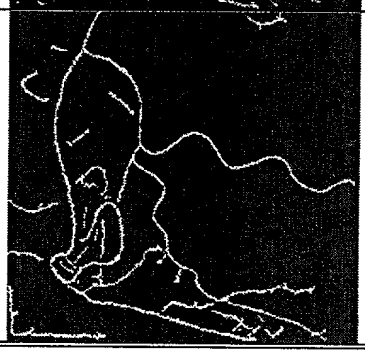
Characteristic of Noise Added	Noise added image	Result of algorithm
No noise added		
$\mu = 0.0$ $\sigma = 0.00008$		
$\mu = 0.0$ $\sigma = 0.0002$		
Histogram rescaled to reduce contrast		

FIG. 22

No.	Process	Time (sec)
1.	Direct Convolution: $\sigma = 3.0$	3.9
2a.	Recursive Filtering: $\sigma = 3.0$ *4^{th} order IIR filter*	3.3
2b.	*3^{rd} order IIR filter*	3.0

FIG. 23

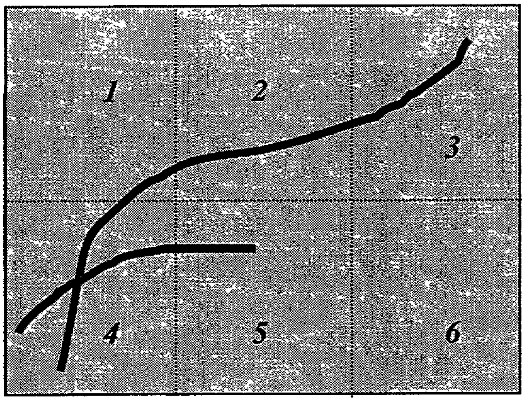


FIG. 24A

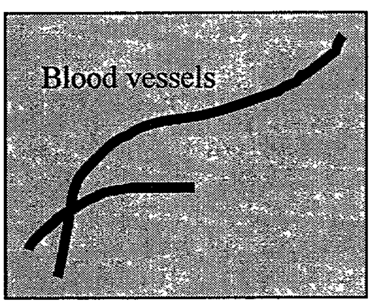


FIG. 24B

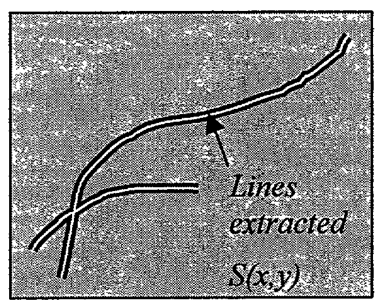


FIG. 24C

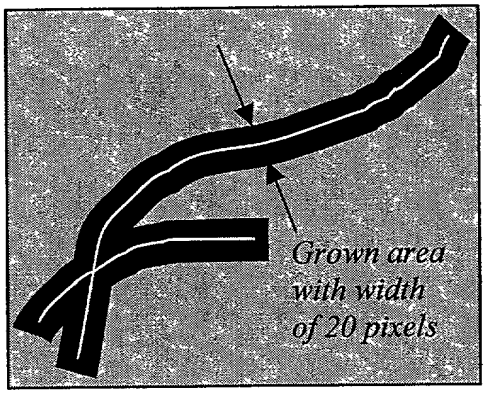


FIG. 24D

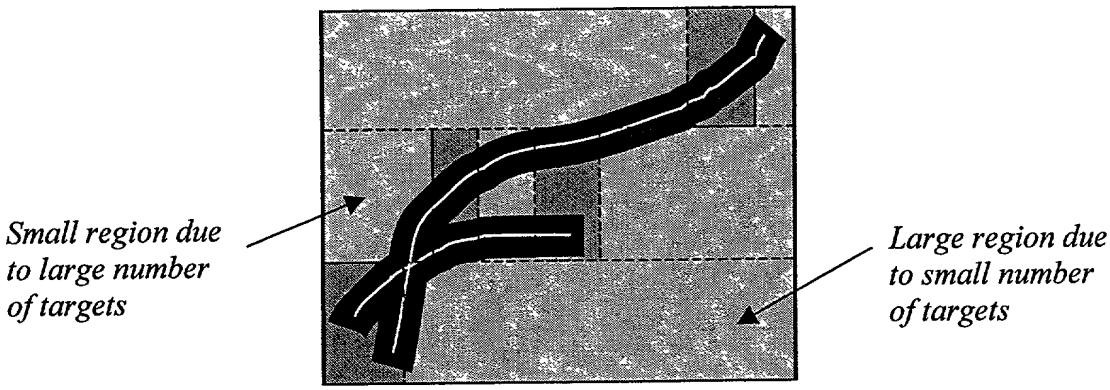


FIG. 24E

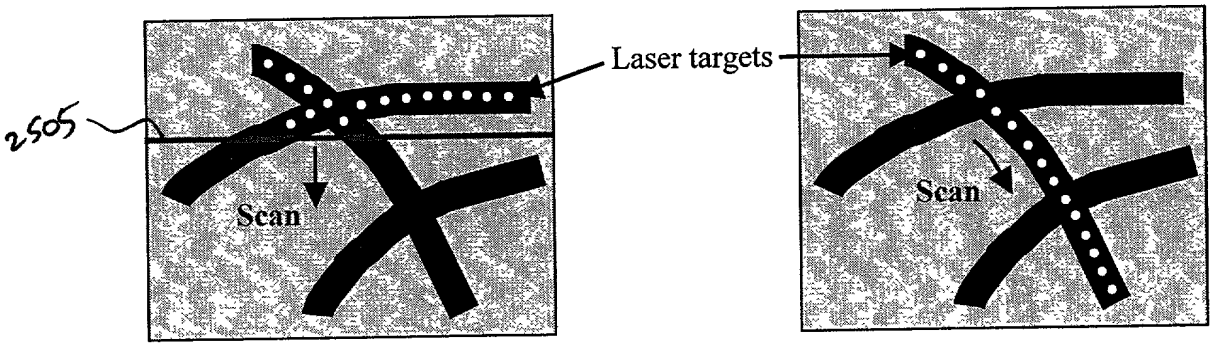


FIG. 25A

FIG. 25B

FIG. 26A

FIG. 26B

FIG. 27A

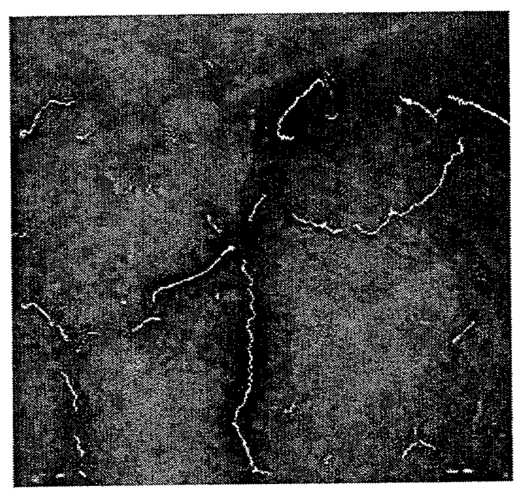


FIG. 27B

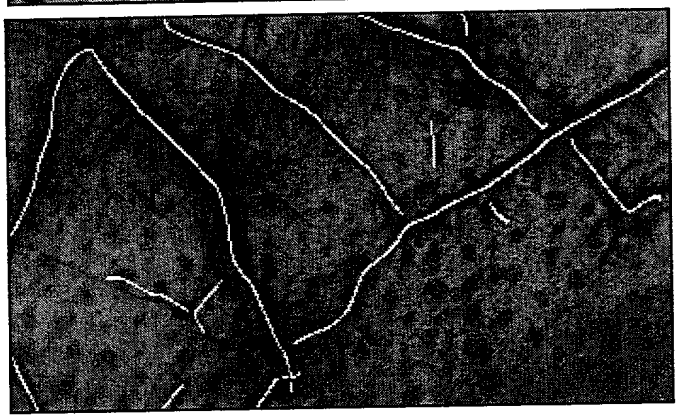
Laser	Coherent Innova 100 CW Argon Laser
Wavelength	514 nm
Beam diameter	750 μm
Power	1 watt
Pulse width	80 ms (CW laser pulsed mechanically)
Fluence	18.1×10^4 J/m^2

Treatment laser parameters

FIG. 28

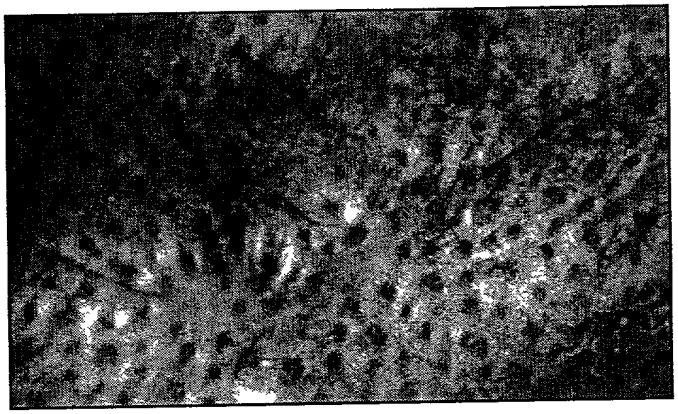
Blood vessels before treatment (illumination at 577 nm).

FIG. 29A



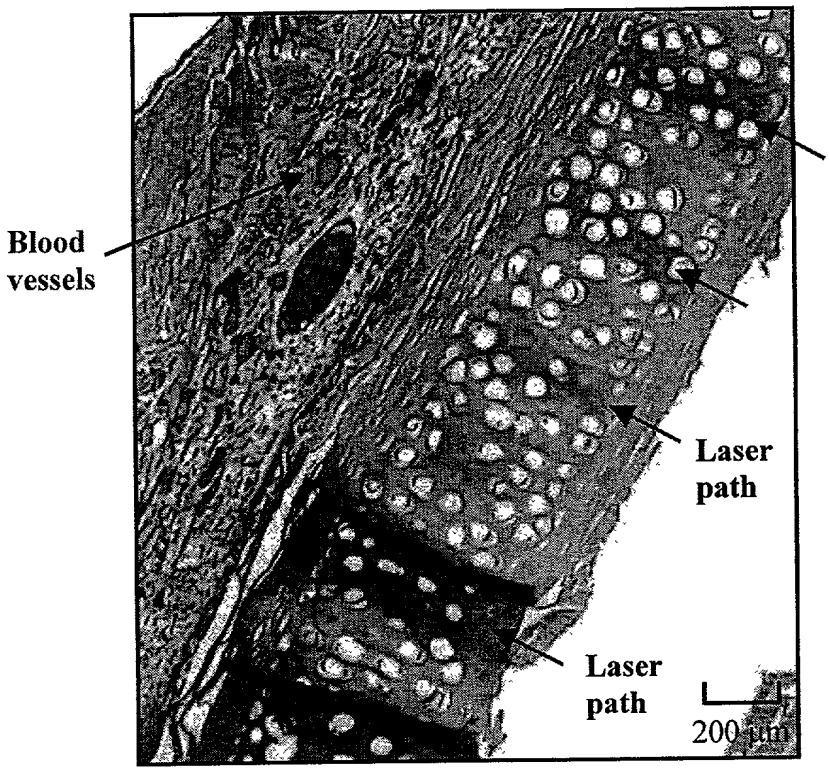
Targets identified by the Smart Scalpel.

FIG. 29B



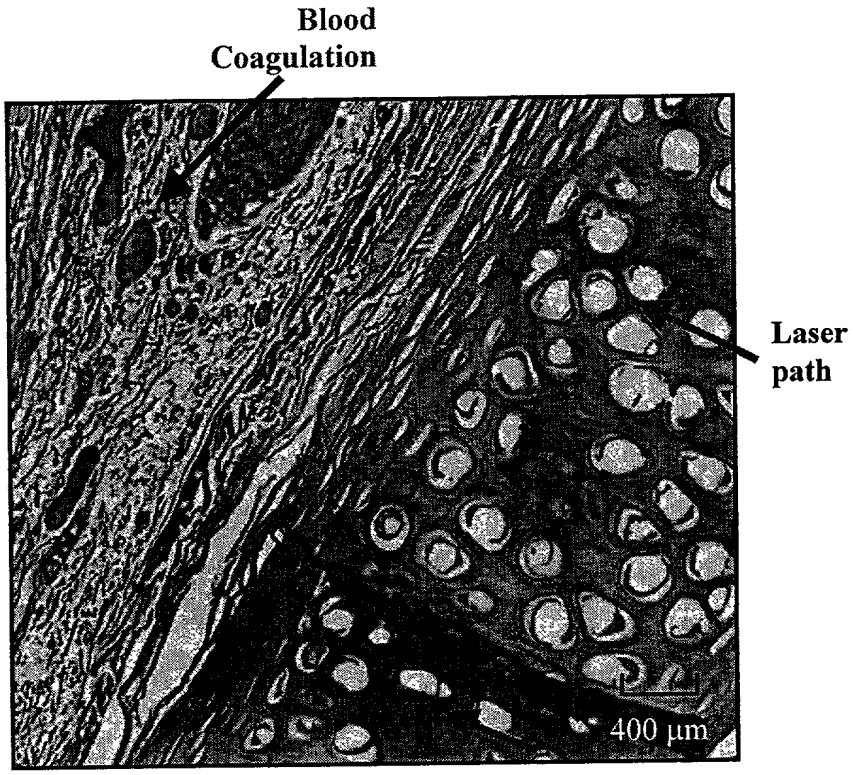
Blood vessels immediately after treatment.

FIG. 29C



Histology results

FIG. 30



Close-up view showing coagulated blood vessels

FIG. 31

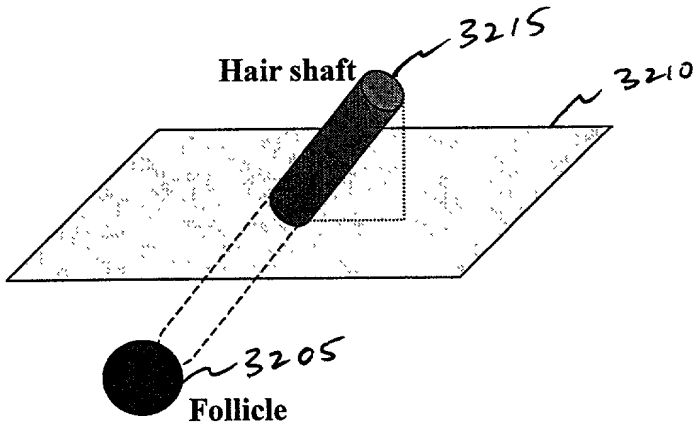


FIG. 32A

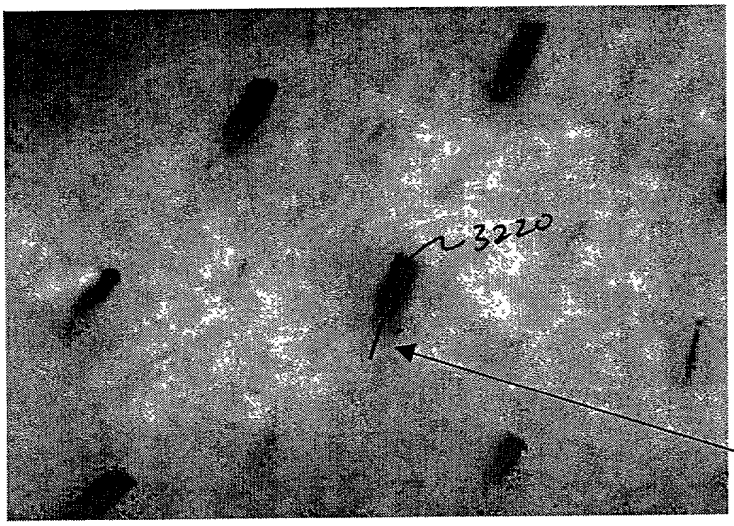


FIG. 32B

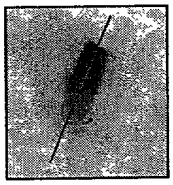


FIG. 32C

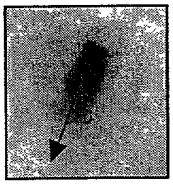
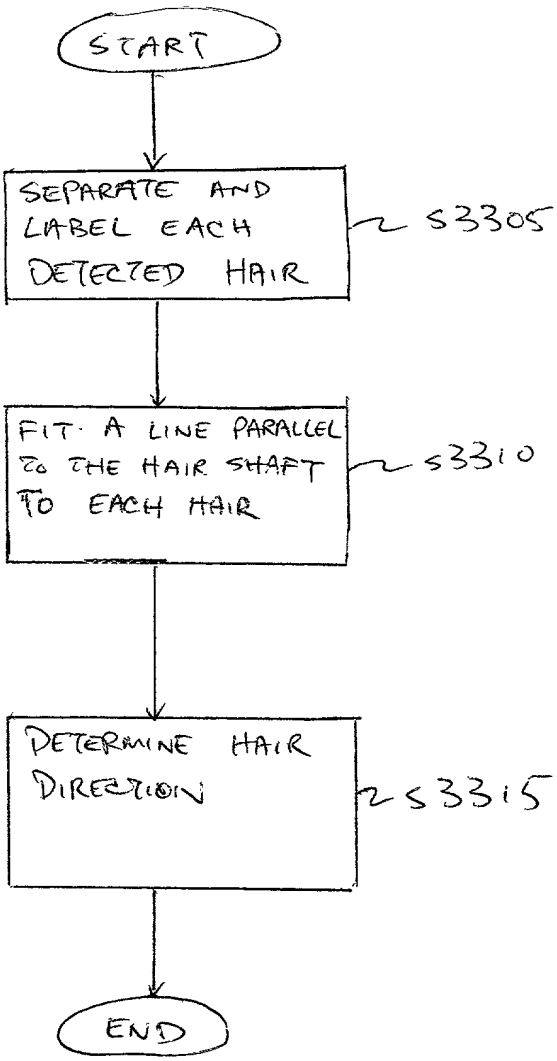


FIG. 32D


START
SEPARATE AND LABEL EACH DETECTED HAIR
S3305
FIT A LINE PARALLEL TO THE HAIR SHAFT TO EACH HAIR
S3310
DETERMINE HAIR DIRECTION
S3315
END

3300

FIG. 33